COSEWIC
Assessment and Status Report

on the

Spotted Wolffish
Anarhichas minor

in Canada

THREATENED
2001

COSEWIC
COMMITTEE ON THE STATUS OF
ENDANGERED WILDLIFE
IN CANADA

COSEPAC
COMITÉ SUR LA SITUATION DES
ESPÈCES EN PÉRIL
AU CANADA

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Également disponible en français sous le titre Rapport du COSEPAC sur la situation du loup tacheté (*Anarhichas minor*) au Canada

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Spotted Wolffish — from Scott and Scott, 1988.

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COSEWIC
Assessment Summary

Assessment Summary – May 2001

Common name
Spotted wolffish

Scientific name
Anarhichas minor

Status
Threatened

Reason for designation
Numbers of this large, slow-growing, long-lived, solitary, nest-building fish have declined over 90% in three generations, and the number of locations where the fish is found has decreased. Threats include mortality as by-catch and habitat alteration by bottom trawling. Dispersal is limited.

Occurrence
Arctic Ocean, Atlantic Ocean

Status history
Designed Threatened in May 2001. Assessment based on a new status report.

COSEWIC
Executive Summary

Spotted Wolffish
Anarhichas minor

Description

Wolffish are characterised by the prominent, canine-like teeth in the front of the jaws, the elongate body, and the lack of pelvic fins. The spotted wolffish, *Anarhichas minor*, is a large, bottom-dwelling predatory fish and is distinguished from the other two Atlantic species by the dark spots on the body, the firm musculature, and the arrangement of the teeth on the roof of the mouth.

Distribution

The spotted wolffish is found in cold, continental shelf and slope waters across the North Atlantic from Scotland to Cape Breton. In the western North Atlantic, it occurs primarily off northeast Newfoundland. Elsewhere in Canadian waters, the species only occurs as an occasional stray.

Habitat

The spotted wolffish is found in waters between 50 and 600 m deep and at temperatures lower than 5°C. It lives generally offshore over sand or mud bottoms and often in proximity to boulders.

General Biology

Spawning occurs in summer. The large eggs are deposited in a mass on the sea bottom. The young remain mostly associated with the bottom, and do not disperse very far. The adults appear only to make limited, perhaps seasonal, migrations. Growth rates are slow, and fish do not become mature until they are 7 to 10 years of age. Spotted wolffish consume a wide variety of prey including crustaceans, molluscs, starfishes, tube worms, sea urchins, seaweeds and sandeels. The primary food source is echinoderms, though fish, particularly discards from fishing trawlers, can comprise a significant proportion of the diet.

Population Size and Trends

Scientific surveys in the western Atlantic show marked declines in abundance over the past 21 years, about 3 wolffish generations. Since 1978, numbers in Newfoundland waters are indicated to be down by 96%, and the fish is found in significantly fewer survey stations. Mean size has also declined over time.

Limiting Factors and Threats

Spotted wolffish figure in commercial landings of Iceland and the Faeroes, but catches are generally small. They are taken as by-catch in the wolffish fishery of the Western North Atlantic. There Canada and Greenland have been the major countries involved since 1980, and Portugal has been important in the 90s. Landings in the western Atlantic peaked in 1979 at around 22,000 tonnes but have fallen steadily to under 2,000 by 1996. Even removals as by-catch have a negative impact on wolffish populations, and bottom trawling which destroys and disrupts habitat is probably detrimental.

Existing Protection

Because the spotted wolffish is not at present the target of a directed fishery in the western Atlantic it is unmanaged and there are no specific mechanisms, such as total allowable catch limits, in place that afford it protection.

COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) determines the national status of wild species, subspecies, varieties, and nationally significant populations that are considered to be at risk in Canada. Designations are made on all native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fish, lepidopterans, molluscs, vascular plants, lichens, and mosses.

COSEWIC MEMBERSHIP

COSEWIC comprises representatives from each provincial and territorial government wildlife agency, four federal agencies (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biosystematic Partnership), three nonjurisdictional members and the co-chairs of the species specialist groups. The committee meets to consider status reports on candidate species.

DEFINITIONS

Species	Any indigenous species, subspecies, variety, or geographically defined population of wild fauna and flora.
Extinct (X)	A species that no longer exists.
Extirpated (XT)	A species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A species facing imminent extirpation or extinction.
Threatened (T)	A species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)*	A species of special concern because of characteristics that make it particularly sensitive to human activities or natural events.
Not at Risk (NAR)**	A species that has been evaluated and found to be not at risk.
Data Deficient (DD)***	A species for which there is insufficient scientific information to support status designation.

* Formerly described as "Vulnerable" from 1990 to 1999, or "Rare" prior to 1990.
** Formerly described as "Not In Any Category", or "No Designation Required."
*** Formerly described as "Indeterminate" from 1994 to 1999 or "ISIBD" (insufficient scientific information on which to base a designation) prior to 1994.

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. Species designated at meetings of the full committee are added to the list.

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The Canadian Wildlife Service, Environment Canada, provides full administrative and financial support to the COSEWIC Secretariat.

COSEWIC Status Report

on the

Spotted Wolffish

Anarhichas minor

in Canada

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2001

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ABSTRACT

The spotted wolffish, *Anarhichas minor* Olafsen 1774, is a large blenny-like marine fish found in moderately deep and cold waters of the North Atlantic on rocky bottoms from eastern Nova Scotia to Scotland. Although it is fished to a moderate degree in Iceland, it has never been the target of a directed fishery in Canada, although it is taken as by-catch. In the western Atlantic, it has been most abundant off Newfoundland and Labrador, where it is a characteristic member of the deep cold-water fish assemblage on the shelf, but its numbers there, as indicated by scientific surveys, declined by 96% between 1978 and 1999. In other Canadian areas, the spotted wolffish occurs only as a stray. Wolffish are relatively sedentary and slow-growing. They make nests, and guard their large eggs. They feed mostly on bottom invertebrates, especially echinoderms. Aggressive trawl fisheries, now in abeyance by the imposition of widespread moratoriums, appear to have had an impact on wolffish numbers. In the Newfoundland region, numbers have declined steadily in scientific surveys, the number of locations where the species occurs is fewer, the range appears to be shrinking, and the mean size has decreased. Slow growth, nesting habit and limited dispersal make rescue unlikely, and bottom trawling and dredging have probably damaged habitat.

SPECIES INFORMATION

Name, Classification

The wolffishes, family Anarhichadidae, are blenny-like marine fishes which inhabit moderately deep waters of the North Atlantic and North Pacific oceans. They are named for the large, conical, canine-like teeth employed in consuming the benthic crustaceans and invertebrates which are their chief food source. All four species of *Anarhichas* occur in Canada, and three are found in the Northwest Atlantic. The Bering wolffish, *Anarhichas orientalis*, lives in the Arctic Ocean; a little-known non-commercial species, it was identified as "Vulnerable" by COSEWIC a decade ago (Houston and McAllister, 1990). Two species, the spotted and the Atlantic wolffishes (*Anarhichas minor* and *Anarhichas lupus)*, are of some commercial importance. The former is the subject of this report.

Description

The spotted wolffish (Figure 1) is an elongate fish with a large head, rounded snout and characteristic large canine-like teeth. It is yellowish or greyish brown to dark brown in colour with numerous distinct spots on its body and a long dorsal fin (Barsukov *in* Whitehead *et al*, 1986; Scott and Scott, 1988). There are no pelvic fins. The spotted wolffish can be distinguished from other wolffish principally by the distinctive spotted pattern on its body and dorsal fin. Additionally, its body musculature is firm and not jelly-like as in *A. denticulatus*, and the row of grinding vomerine teeth reaches backwards as far as do the rows of palatine teeth (Barsukov *in* Whitehead *et al*, 1986).

Figure 1. The spotted wolffish *Anarhichas minor*. From Scott and Scott 1988.

DISTRIBUTION

Global Range

The spotted wolffish is found on both sides of the North Atlantic Ocean. In the western North Atlantic, it is found from Greenland to the Scotian Shelf with occasional rare strays south as far as Cape Ann, Massachusetts. Bigelow and Schroeder (1953) note its rarity west of Cape Sable and remark that "it is only an accidental waif from its Arctic home, one to be watched for but hardly expected". In the eastern North Atlantic it is found on the north coast of Russia, the White and Barents Seas, and from Iceland south to Bergen, Norway (Whitehead *et al*, 1986; Scott and Scott, 1988). The type specimen was taken at Iceland (Goode and Bean, 1895). Thus the spotted wolffish is basically a coldwater fish, and Mahon *et al*. (1998) identify it as a characteristic member of the "northern, cold, deep, aggregated" demersal fish assemblage that occurs on the deep continental shelves off northeastern Newfoundland and Labrador.

The spotted wolffish appears in the important regional ichthyofaunal compendia of the North Atlantic: "The Fishes of the British Isles and North West Europe" by Wheeler, 1969, pp. 451; "Fishes of the North-eastern Atlantic and the Mediterranean" by Whitehead *et al.*, 1986 as Clofnam species 165.1.3 on pp. 1115-1116; "Atlantic Fishes of Canada" by Scott and Scott, 1988, pp. 434-436; and "Fishes of the Gulf of Maine" by Bigelow and Schroeder, 1953, pp. 375-376. These accounts each include keys, an illustration, distribution map and information on biology and relation to man as well as references.

Canadian Range

The ECNASAP (East Coast of North America Strategic Assessment Project) on-line Groundfish Atlas (http://www-orca.nos.noaa.gov/projects/ecnasap/ecnasap.html) summarizes twenty years of distributional data from scientific research surveys conducted in the western North Atlantic in the map SPTWOL, reproduced here as Figure 2. ECNASAP is a joint US/Canada data synthesis and mapping project concerned with living marine resources and their habitats. The map shows that the distribution of spotted wolffish in the western Atlantic is entirely Canadian. Within that area, it is most prevalent and abundant on the deep shelf off northeastern Newfoundland and Labrador.

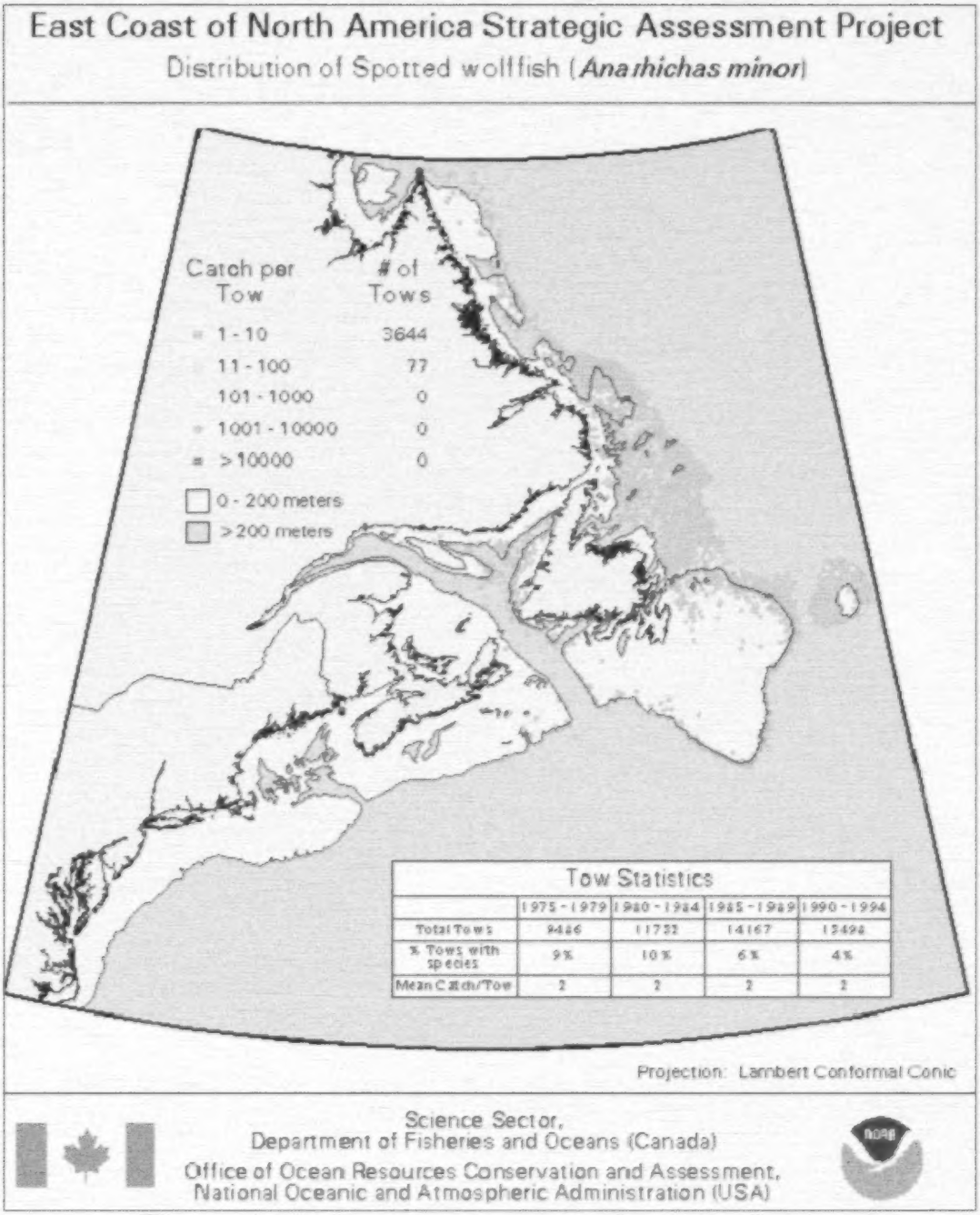

Figure 2. Composite map of the western Atlantic distribution of *Anarhichas minor*, from the ECNASAP website - http://www-orca.nos.noaa.gov/projects/ecnasap/maps/sptwol.gif.

HABITAT

Definition

The spotted wolffish is a deepwater fish of cold northern seas. Occurring in waters between 50 and 600 m deep and at temperatures lower than 5°C, it lives offshore over sand or mud bottoms and often in proximity to boulders. Like other wolffish it does not form large schools, although unusually large catches occur on rare occasions (Templeman, 1986). Tagging studies indicate that migrations are local and limited (Templeman, 1984).

Trends

Survey maps show that the number of sites where spotted wolffish are caught steadily declines (Fig. 3). Stations where wolffish occurred are shown as closed dark circles and stations where they were absent by open circles. By the mid-90s, wolffish are encountered in far fewer places than they had been a decade earlier, and mainly at the offshore and deeper periphery of the range. This change has been a steady and unidirectional one since the mid-80s. In the early part of the series, 40% or more of sites at appropriate depths and temperatures for northern wolffish contained the fish, but by 1993 the percentage had dropped to less than 6% (Fig. 4). The 1986-1999 DFO data show a similar trend as indicated by the generally declining percentage of successful wolffish tows over time (Fig. 4).

GENERAL BIOLOGY

Reproduction

In the western North Atlantic spotted wolffish spawn in the summer (Templeman, 1986). In the waters of western Greenland females mature generally one year earlier and at smaller size, between 48 and 62 cm, than do males who mature between 53 and 71 cm. Data from otoliths and vertebrae indicate that fish of those lengths are 7 to 10 years old. Large eggs are laid in clusters on the bottom in deep water and pelagic larvae are found over the continental slopes. Females of 66 cm off Newfoundland contain about 5000 eggs (Templeman, 1986), and the mean fecundity in the Barents Sea is 19,000 (Gusev and Shevelev, 1997).

Growth rates of the spotted wolffish in Canadian Atlantic waters are unknown and there is little data available for other areas. It is known that the spotted wolffish grows more slowly than its relatives the Atlantic and the northern wolffish. Maturity is reached at around 50 cm in length, when the fish is at least 7 years old. Living upwards of 21 years, the spotted wolffish may attain 150 cm in length. A specimen of 110 cm weighs about 16 kg.

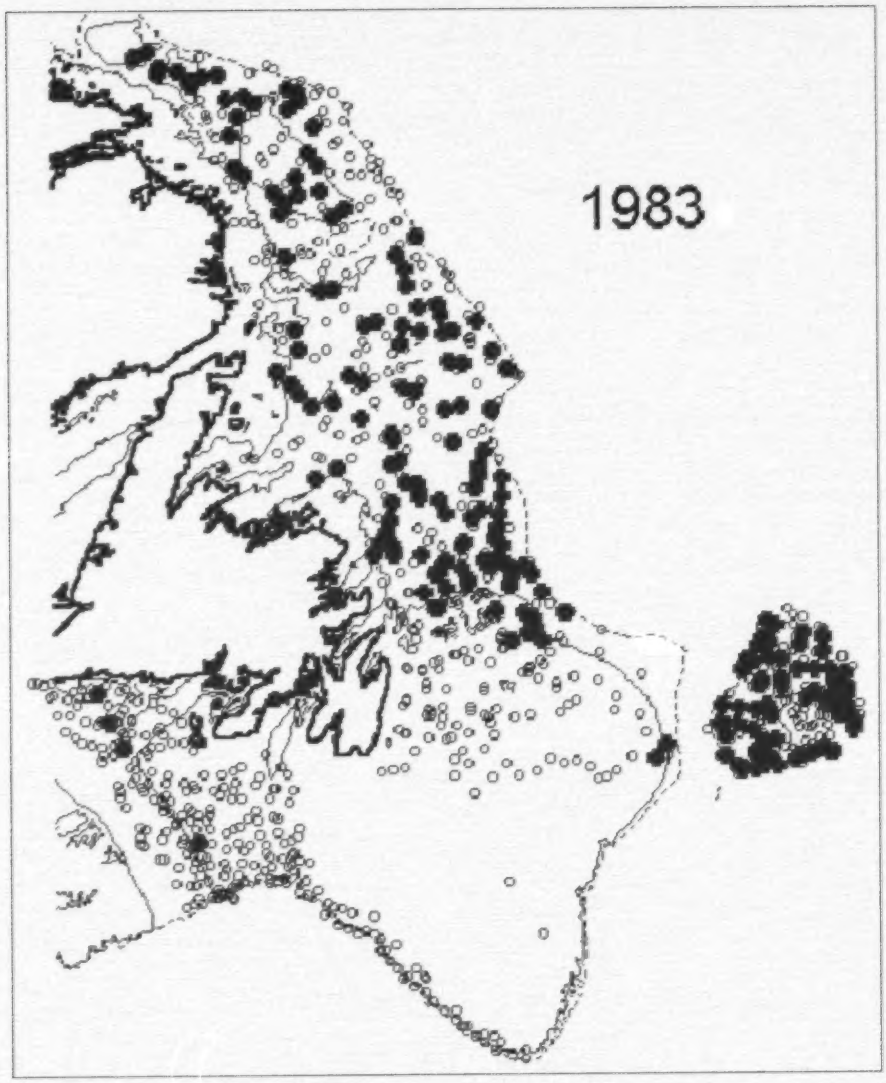

Figure 3a. Occurrence (presence/absence) of spotted wolffish, *Anarhichas minor*, in Newfoundland waters in 1983. ECNASP Data. Stations where wolffish occurred are indicated by a closed black circle, and stations where wolffish were absent by an open circle. The Flemish Cap, the isolated bank to the east, lies in international waters.

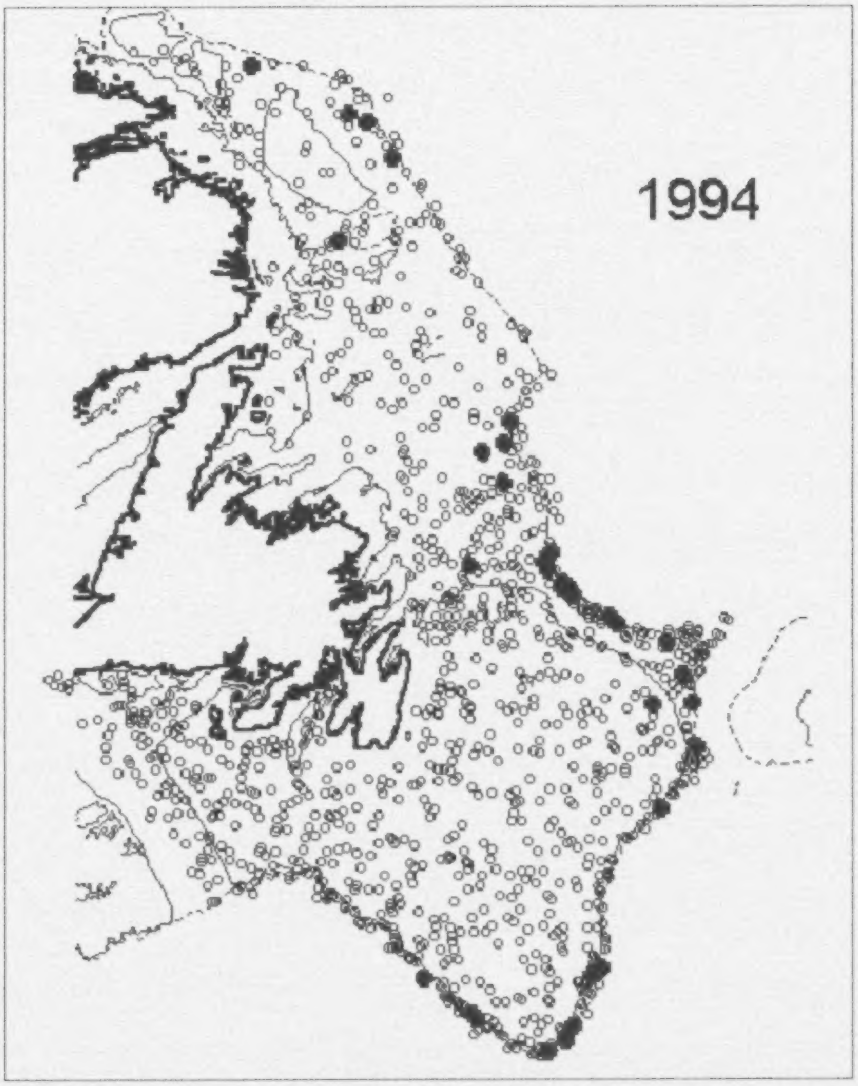

Figure 3b. Occurrence (presence/absence) of spotted wolffish, *Anarhichas minor*, in Newfoundland waters in 1994. ECNASP Data. Stations where wolffish occurred are indicated by a closed black circle, and stations where wolffish were absent by an open circle. Note that there are more deeper samples than there were in 1982. No data from Flemish Cap were available.

Figure 3c. Occurrence (presence/absence of spotted wolffish, *Anarhichas minor*, in Newfoundland waters in 1996. DFO data provided in July 2001. Since these data were gathered with a different sampling gear, the maps are not directly comparable to those from 1983 and 1994. Stations where adult wolffish occurred are indicated by a closed black circle, stations where juveniles occurred by a cross, and stations where wolffish were absent by an open circle.

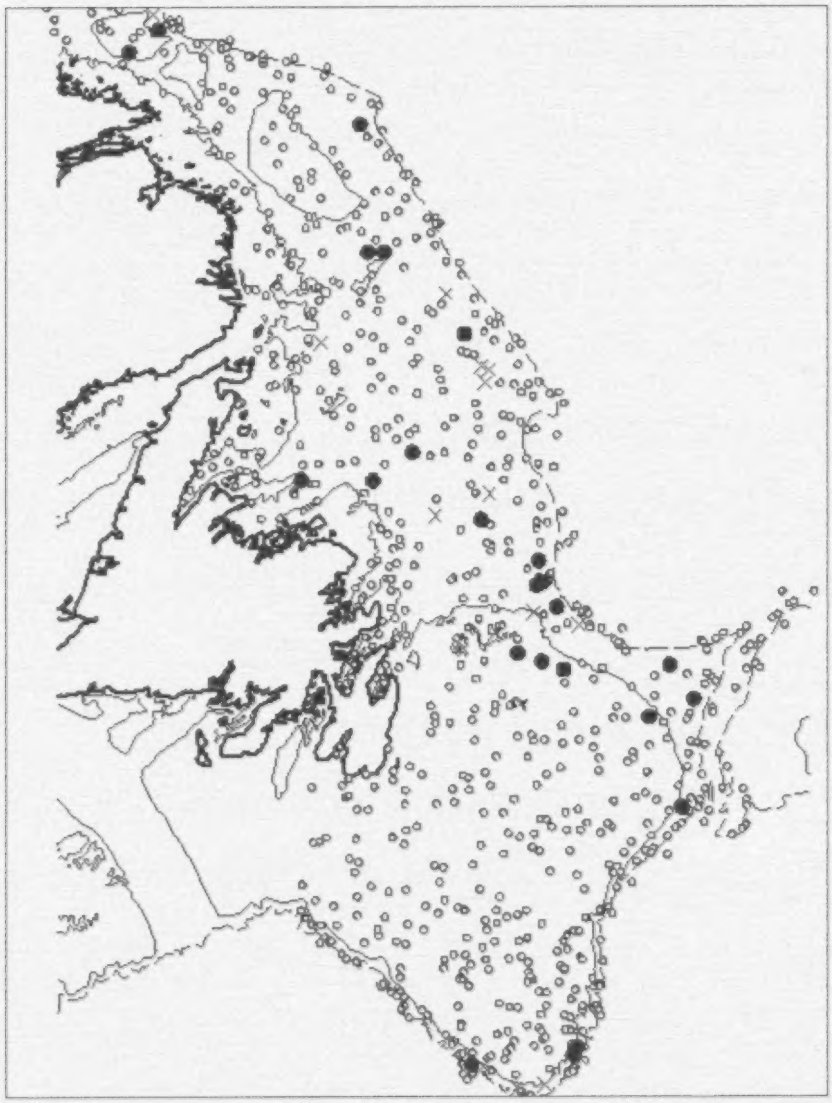

Figure 3d. Occurrence (presence/absence) of spotted wolffish, *Anarhichas minor*, in Newfoundland water in 1998. DFO data provided in July 2001. Since these data were gathered with a different sampling gear, the maps are not directly comparable to those from 1983 and 1994. Stations where adult wolffish occurred are indicated by a closed black circle, stations where juveniles occurred by a cross, and stations where wolffish were absent by an open circle.

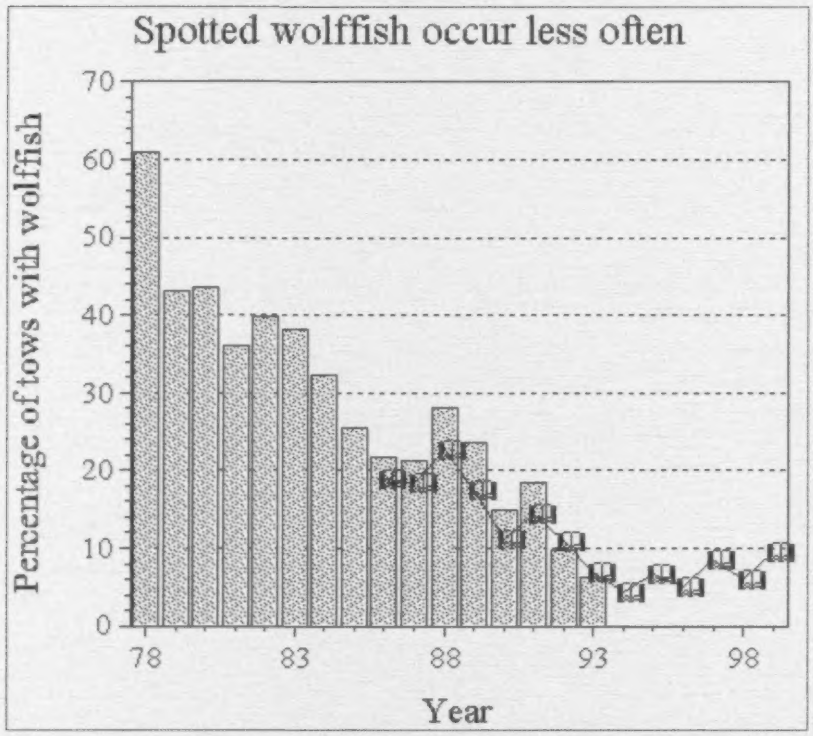

Figure 4. Bars: Percentage of stations within appropriate depth and temperature ranges where the spotted wolffish, *Anarhichas minor*, was caught, 1978-1993 off Newfoundland. The ranges are those within which the wolffish is most likely to be encountered (Fischer and Haedrich, 1999), 50 to 600 m for depth and -0.6 to 5.0°C for temperature. Line: percentage of surveys tows which took wolffish 1986-1999; information provided by DFO in July 2000.

Nutrition and Interspecific Interactions

The spotted wolffish is a benthic feeder of deep waters. It consumes a wide variety of hard-shelled invertebrates such as crustaceans and molluscs in addition to starfishes, tube worms, sea urchins, seaweeds and sandeels. Feeding is more intense in the summer-autumn period than in the autumn-winter period, and is much more intense in September than in May. The spotted wolffish's primary food source is echinoderms, though fish, particularly discards from fishing trawlers, can comprise a significant proportion of their diet. Little is known about what preys on the spotted wolffish itself, but it has been reported in the stomach contents of cod, pollock, and Greenland shark.

POPULATION SIZE AND TRENDS

Data from random-stratified scientific survey trawls off eastern Newfoundland (Atkinson, 1994) were provided by Canada's Department of Fisheries and Oceans and summarized by Villagarcía (1995; see also Haedrich and Barnes, 1997). The surveys

are intended mainly to assess the size of commercial fish stocks, but they also catch most species in the demersal fish community (Brown *et al.*, 1996). The number of individual trawls made (the number of stations) in any one year off eastern Newfoundland can be over six hundred.

The number/tow (which fishery biologists refer to as the "catch per unit effort" or CPUE) from scientific surveys is used as an index of population size. Over the period from 1978 to 1993, this index was calculated as the total number of spotted wolffish caught in a year divided by the total number of stations sampled at appropriate depth and temperature ranges for the species in that year. The appropriate depth and temperature ranges for the spotted wolffish are determined using the niche axis approach developed by Fischer and Haedrich (1999) and represent the ranges of those two environmental parameters within which the wolffish is most likely to be encountered, i.e. 50 to 600 m for depth and -0.6 to 5.0°C for temperature.

The scientific survey data indicate a sharp decline in the population size of the spotted wolffish. The number/tow was highest in 1978 with an average of 1.25 individuals caught in each tow. The following year it dropped almost 25% to 0.83 individuals per tow. In 1982 the number/tow rallied to over 1.00, but thereafter it fell steadily. By 1984 it had dropped to less than 0.60, and by 1993 it had fallen to just 0.09 individuals per tow. Over the full period from 1978 through 1993, 16 years or about two wolffish generations, the number/tow declined by 93% (Fig. 5). The population decline rate over the ECNASAP time series 1978-1994 is also 93%. In the northern Gulf of St. Lawrence, where the wolffish in general is much less abundant (average number/tow since 1983 = 0.03), the overall population decline has nonetheless been significant and similarly great, 97% from 1983 to 1994. Since 1995, a different sampling protocol has been followed off Newfoundland (bigger net, smaller mesh, faster speed, shorter time), and results cannot be strictly compared. Nonetheless, data provided by DFO in July 2000 show that numbers do remain very low and there has been no significant change in the downward trend (Fig. 5). The total decline calculated from 1978 to 1999 is 96%.

DFO's main population assessment tool is the STRAP computer program. This analysis takes catches from at least two trawls within defined strata, scales them according to the total area of the stratum (within which the species is assumed to be uniformly abundant), and calculates an estimated number of fish presumed present. To get a total, those numbers are summed across all strata where the fish was encountered. The size of a single stratum ranges from 30 to 2817 square nautical miles. The average stratum size is 697 sq n mi (25,748,576,526 sq ft); since each survey trawl covers about 274,000 sq ft, the scale-up is prodigious (Schneider *et al.*, 1999).

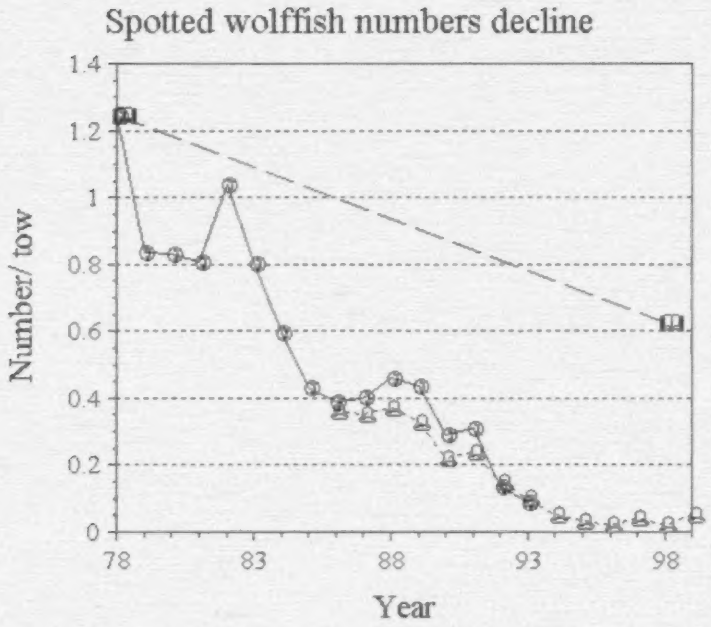

Figure 5. Number of spotted wolffish, *Anarhichas minor*, caught in fall survey tows within appropriate depth and temperature ranges off Newfoundland, 1978-1993. The ranges are those within which the fish is most likely to be encountered (Fischer and Haedrich, 1999), 50 to 600 m for depth and -0.6 to 5.0°C for temperature. Catch rates for 1986-1999 (dotted line) are from information provided in July 2000 by DFO. Data for 1995-1999 were collected using different sampling protocols which are expected to over-estimate parameters relative to earlier samples; these rates are adjusted by the Campelen/Engels conversion factor 3.1 (Bundy et al., 2000). The dashed line shows the COSEWIC "Endangered" criterion, 50% decline over three generations.

STRAP analysis results for spotted wolffish from 1981 to 1999 are shown in Table 1. Because the sampling protocol changed in 1995, values after 1994 must be divided by a correction factor for comparability. For demersal species like wolffish, that factor ranges from 3.1 for adults to 10.7 for juveniles (Bundy *et al.*, 2000). The STRAP results also indicate a large decline in the wolffish population; the total estimate is down 90.5% over the 12 years (about 1.5 wolffish generations) from 1982 to 1994 (no change in sampling protocol). From 1982 to 1999, a little more than 2 wolffish generations and with the later catches adjusted by 3.1, the decline indicated is 93%. Despite the questionable value of STRAP's absolute numbers, the annual estimates are well-correlated ($r = 0.91$) with the simple metric we prefer, the number/tow.

Though not as remarkable as the decline in population, the size of spotted wolffish has also declined in recent years, from about 5.6 kg in 1987 to 1.2 kg in 1996 (Fig. 6), an almost five-fold reduction. Fish of the latter size are probably not yet mature. The change in gear in 1995 favoured the capture of juveniles. Before 1991, 90% of annual wolffish collections were >1.2 kg in average size, but after 1995 only 35% were. Before 1995, 2.4% of collections were <200 gm in average size, but when the gear changed that percentage increased to 35%.

Table 1. DFO's estimated numbers of spotted wolffish in Newfoundland waters, where the species is most abundant. This information, the result of the Department's standardly applied STRAP analysis, was provided by DFO in July 2000. Data after 1995, when the sampling protocol changed, are adjusted by the Campelen:Engels factor 3.1 (Bundy *et al.*, 2000)

Estimated number of spotted wolffish Divisions 2J3KL			Number actually caught in survey
Year	Maximum	Minimum	
1981	7705887.97	2774076.52	248
1982	8701825.19	4087862.14	419
1986	4327502.37	1545470.74	128
1987	2965369.66	1418783.17	158
1988	3385562.76	1039927.24	158
1989	3026177.19	1272354.84	147
1990	1602399.4	378467.35	88
1991	1498223.53	316486.25	130
1992	1367933.84	-4739.94	81
1993	1014307.92	-321722.89	40
1994	1228654.01	-18815.02	21
1995	326055.04	-106456.09	36
1996	856676.45	5194.87	33
1997	857454.14	142378.52	55
1998	738833.29	112552.1	37
1999	673218.64	216727.24	66

LIMITING FACTORS AND THREATS

There are no direct studies of factors responsible for the declines observed in wolffish abundance. Following the dramatic collapse of the northern cod off Newfoundland in 1992, however, a number of causes for that decline were suggested, including especially environmental changes. But the emerging consensus today is that, while environment may have played some role, overfishing was clearly the primary cause of the declines observed in cod and other groundfish species (Sinclair and Murawski, 1997; Villagarcía *et al.*, 1999). Overfishing in the area is argued to have been responsible for the extraordinary decline of the non-commercial but large and once abundant and widely-distributed barndoor skate, *Raja laevis* (Casey and Myers, 1998).

The spotted wolffish does not occur in sufficient numbers in Canadian waters to be the target of a directed fishery, though it is taken as by-catch by offshore trawlers along with Atlantic wolffish. In Greenland, however, the spotted wolffish is a favourite food and has been caught on longlines since 1948.

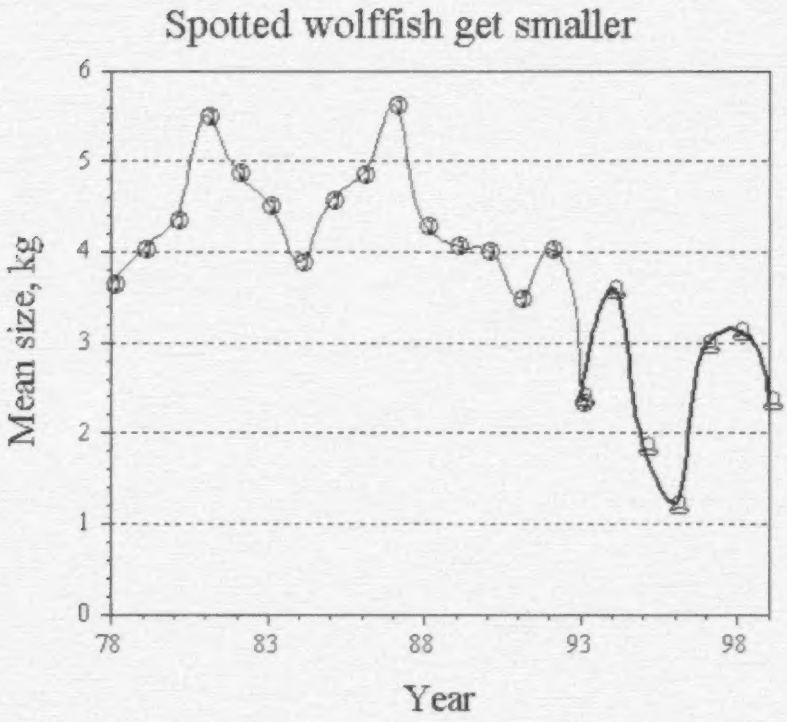

Figure 6. Mean size of spotted wolffish, *Anarhichas minor*, 1978-1999. DFO Newfoundland Fall Survey Data. Uncorrected data from 1995-1999 (x's, heavy line) provided by DFO in July 2000, were collected using different sampling protocols which are expected to over-estimate parameters relative to earlier samples.

In fisheries data compiled by the Food and Agriculture Organization of the United Nations (FAO), wolffish landings for the western North Atlantic are reported for the whole family rather than for each individual species. The eastern North Atlantic wolffish fishery has had annual landings of around 30,000 tonnes since the late 1950s, with two peaks of more than 50,000 tonnes in 1962 and 1974, but catches are now increasing and were up rather sharply to 45,000 tonnes in 1997. The western North Atlantic fishery (based mostly on Atlantic wolffish) has always been considerably smaller. Northwest Atlantic landings hovered around 5,000 tonnes through the 1950s and then rose through the 1960s and 1970s to a peak of 22,000 tonnes in 1979. Landings then declined steadily through the 1980s and 1990s; in 1984 they stood at 6,000 tonnes and by 1996 they had fallen to a mere 1,700 tonnes but have begun to increase again recently.

Only Iceland and the Faeroes report fishery landings of spotted wolffish, and these are all taken in the Northeast Atlantic. The Faeroes take negligible amounts but the amounts are increasing; the largest catch reported is 64 tonnes in 1997. Landings by Iceland have been stable around 975 tonnes annually since 1984.

Apart from the direct adverse impact of fisheries on spotted wolffish, human activities also have indirect and detrimental effects on this species. The groundfish trawls in which wolffish are caught also result in incidental mortality and damage to fish which come in contact with the mobile fishing gear but are not caught. Perhaps even more importantly, the steel doors of the net, along with heavy bottom lines and rollers, scour the seabed as they are dragged across it (Watling and Norse, 1998). This practice may cause significant habitat damage by removing or re-distributing the rocks and boulders under which these fish shelter, spawn and build nests. Studies on Georges Bank (Collie *et al.*, 1997) and in the Gulf of Maine (Auster *et al.*, 1996), areas just to the south of the spotted wolffish's range, show the considerable degree of damage that can result from bottom dragging. Jennings and Kaiser (1998) provide an excellent overview of the entire question of fishing impacts on habitat; they point out that these can vary quite a bit depending on local conditions, but suggest that the greatest and most lasting impacts are most likely to occur on hard substrates in deep water, i.e. just those habitats favoured by wolffish.

Bottom trawling for fish and dredging for scallops and clams, in addition to digging up and disrupting bottom habitats, also resuspend bottom sediments which can smother spawning areas and damage gills. Other activities such as dredging and aggregate extraction harm bottom habitats on the Canadian continental shelf by destabilizing the seabed, increasing erosion, and polluting previously healthy areas (Messieh *et al.*, 1991).

The period since 1992 is an anomalous one for all these waters. Relative to the past, fish populations are at an all-time low. For that reason, bans on fishing (moratoria) have been in effect in most regions for various periods of time, and these continue in the Newfoundland region. Fishing predation is thus much relaxed, and populations should do better as long as that situation continues, which will not be forever. A cornerstone in the Fisheries Resource Conservation Council's approach to management (this quasi-independent group advises the Minister on the status of commercial fish stocks) is adherence to the precautionary principle (FRCC, 1996). That principle - when in doubt, err on the side of the fish - should also apply in regard to COSEWIC status.

SPECIAL SIGNIFICANCE OF THE SPECIES

The spotted wolffish's flesh is fit for human consumption and its spotted skin is tanned for leather. While its abundance is so limited that it has no significant commercial value in the western Atlantic, it is a species of the artisanal fisheries of Greenland, utilized both for its skin and flesh. Though its role as a forage fish is undetermined, it does appear to be a food source for several species.

EVALUATION AND PROPOSED STATUS

Existing Legal Protection or Other Status

Because the spotted wolffish is not the target of a directed fishery in the western North Atlantic it is unmanaged and there are no specific mechanisms, such as total allowable catch limits, in place to afford this species protection. Possibility for protection may exist under the Habitat Section of the Fisheries Act. The Canadian Atlantic groundfish moratorium imposed in 1992 in response to the collapse of the fishery for Atlantic cod, *Gadus morhua*, may have provided some indirect protection for the wolffish by reducing trawling pressure. The spotted wolffish currently has no status under COSEWIC, IUCN, or other conventions on species protection.

The physical habitat of the spotted wolffish may provide it with some limited protection. As it lives right on the bottom, it is unlikely to be caught in trawls above the ocean floor. Furthermore, it frequents caves and crevices between and under large rocks, potentially affording at least some protection from bottom trawls and dredges.

Assessment of Status and Authors' Recommendation

Under IUCN Categories and Criteria criterion A: 'Declining Population', the spotted wolffish, with its 93% decline rate over a bit more than 2 generations, would fall in the category Critically Endangered, defined as a "population decline rate at least 80% in 10 years or 3 generations."

Musick (1999) feels that marine fish, by virtue of their widespread distribution and thus relatively great abundance, should be treated differently from other species in respect to consideration as species at risk. He proposes an approach that involves two steps, first determining the productivity class of a species (based on growth, fecundity and age characteristics) and then classifying it on the basis of arbitrary decline thresholds. The spotted wolffish, on the basis of age at maturity and lifespan, falls in Musick's (1999) 'Low' productivity category, and exhibits a decline of 96% over three generations, well above the 85% decline threshold for species in the Low category. According to Musick's proposed scheme, the spotted wolffish would automatically be listed as Vulnerable and would then be subjected to closer scrutiny for final classification. That scrutiny would explicitly consider issues concerning the shrinking range, local distribution, nesting habit, and possibility of habitat destruction. The data available on all these issues support upgrading.

Hutchings (2000, 2001), with a well-argued and scientifically-documented critique, shows that exemption of marine fish from established species-at-risk criteria (as Musick suggests) cannot be supported on the basis of empirical data and, furthermore, that to do so would be inconsistent with a precautionary approach to fisheries management and the conservation of biodiversity. He further argues that extinction risk alone is not very useful from either a management or an ecological perspective and that the other face of the issue, the probability of recovery, should be weighed seriously in assigning status. He suggests a classification scheme that would replace Vulnerable to Critically Endangered

with Conservation Categories ranging from Priority I to IV. The empirical data show that population recovery in marine fish is negatively correlated to the magnitude of population decline. With its high decline rate of 93%, the likelihood that spotted wolffish populations would show signs of recovery after 15 years is very low, and this species would certainly fall in Hutching's Conservation Category Priority IV, his highest rating.

The scientific survey data indicate a 93% decline in the Canadian population of spotted wolffish over about 2 generations, the 16 years from 1978 to 1993 and the overall decline from 1978 to 1999 is estimated to be 96%. Under criterion A: 'Declining Population' of COSEWIC's Risk Categories and Criteria, this population decline rate places the spotted wolffish well within the category Endangered, defined as a "population decline rate at least 50% in 10 yrs or 3 generations." Consideration of all other information available on the biology of this species suggests no reason why this classification should be modified. On this basis we recommend that the northern wolffish, *Anarhichas minor* Olafsen 1774, be designated an Endangered Species. This designation is consistent with evaluations based on other schemes as well, as outlined above.

Summing up:

a) The spotted wolffish, *Anarhichas minor* Olafsen 1774, is eligible for assessment because it breeds in Canada and has its centre of distribution there in the western Atlantic.
b) Numbers have declined steadily as shown in scientific surveys (Fig. 5), the range is shrinking (Fig. 3) and the number of locations where the species occurs has declined (Fig. 4).
c) Slow growth, nesting habit and limited dispersal make rescue unlikely. Populations in Greenland, separated from Canada by a broad expanse of unsuitable deep water in the Labrador Basin, are declining or only holding steady.
d) Bottom trawling and dredging have probably damaged habitat.

TECHNICAL SUMMARY

spotted wolffish — loup tacheté
Anarhichas minor

- Suborder Perciformes, Family Anarhichadidae; large (150 cm, 20 kg), benthic, long-lived and late-maturing, territorial, solitary, nest-building fish; diet comprised mostly of invertebrates;

Distribution	
• *extent of occurrence (sq km)*	>400,000 km^2
• *area of occupancy (sq km)*	Increasingly found at fringes of distribution
• *range jurisdictions (occurs in which provinces & territories?)*	NF,NS,QC, Nunavut
Population information	
• *total number of individuals in Canadian population*	Many
• *number of mature individuals (capable of reproduction) in the Canadian population*	Unknown, but proportion declining
• *generation time (indicate years, months, days, etc.)*	7 years minimum
• *population trend (decline, stable, increase, unknown)*	Decline
• *if in decline, % decline over 10 years or 3 generations whichever is greater (or specify if for shorter time period)*	93% over 3 generations
• *number of sub-populations (geographically or otherwise distinct groups between which there is little exchange i.e. <=1 successful migrant/yr)*	Unknown
• *number of individuals in each sub-population*	Unknown
• *number of extant sites*	Unknown
• *number of historic sites from which species has been extirpated*	In 1994, found in ca. 30% of sites where expected
• *is the population severely fragmented (most individuals found within small and relatively isolated sub-populations)?*	Yes
• *does the species undergo extreme fluctuations (population size or distribution area varies widely, rapidly, and frequently (typically >1 order of magnitude)?*	No
Threats (actual or imminent threats to populations or habitats)	
Anthropogenic influence: aggressive fishing with wolffish killed as bycatch Habitat loss: nesting and shelter habitat can be extensively damaged by bottom trawls	
Rescue Effect (immigration from an outside source)	
• *does species exist elsewhere (in Canada or outside)?*	Yes
• *status of the outside population(s)?*	Declining
• *is immigration possible?*	Yes
• *would immigrants be adapted to survive here?*	Probably
• *is there sufficient habitat for immigrants here?*	Unknown
Criteria met and category: satisfies COSEWIC A1b for "Endangered"	
Precautionary Principle applicable	
Sources of Information: ECNASAP database; DFO scientific survey cruises 1978-1996, with additions to 1998. Literature cited in report.	

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